Jig for CNC Machine

This invention relates to jigs for Computer Numerical Control (CNC) machines and in particular to jigs for CNC machines for machining, manipulating, drilling holes in, and/or cutting the outline of, lenses for rimless spectacles.

There is a requirement for being able to drill holes in spectacle lenses to receive side arms and nose rests that sit adjacent to the bridge of the wearer's nose. The perimeter shape and sizes of lenses are many and varied as are the location of the holes that are required. Furthermore, different prescriptions of optical properties dictate varying thicknesses of lenses and different contours of the concave surface of the lenses that face the eye of the wearer.

The convex surface of the lens is generally of uniform curvature from one lens to another because the optical properties of the lens is achieved by machining and polishing the concave surface. The widely accepted way used throughout the ophthalmic industry for manufacturing lenses, is to take a standard circular part-spherical blank of the appropriate optical grade glass or plastic material, and bond a temporary mounting block onto the convex surface of the lens. The mounting block includes features that enable the blank to be held firmly in a jig at a predetermined datum position. This mounting block is subsequently removed only after machining and polishing work has been completed.

With the lens firmly mounted by way of the mounting block in a jig, the peripheral shape or contour of the lens and the manufacture of the optical properties of the lens (by grinding and polishing the concave surface of the lens) is completed. This is usually done in two different CNC machines; one for cutting the profile and one for grinding the optical properties.

The applicant has a well known machine called an "optidrill" (a Trademark of Berkshire Ophthalmic Laboratories Limited) that is used to drill holes in the finished lenses, but because the lenses arrive at the drilling machine with the mounting blocks firmly bonded to the convex surface, all drilling of the holes has to be done from the concave side of the lens. Hence the prior known optidrill comprises a vertically mounted rotary drill and a rocking table that has restricted tilting movement. The table is mounted on a two axis coordinate movement bed of a CNC machine that is controlled by software to move each lens into the correct position under the drill whilst holding the table by hand in one of two tilted positions. The tilted positions are at each end of a fairly restricted arc of movement. The drill bit enters the concave surface of the lens in a direction substantially normal to the concave surface.

The applicant is also aware of a prior known drilling machine for drilling from the concave surface of the lens towards the convex surface of the lens. In this prior known apparatus the lenses are mounted flat on a two axis coordinate movement

bed of a CNC machine, the lenses are not tilted, instead the drill itself is tilted through an angle so as to drill the appropriate hole.

Whilst these approaches are adequate for some combinations of lens sizes and some prescriptions of optical properties, inaccuracies and wrongly directed holes often occur because of the thickness and profile of the concave surface at the point of entry of the drill. These inaccuracies have to be designed out by bending or modifying the side arms or nose rests of the frame of the spectacles. Often, additional slots have to be machined into the side edges of the lens in order to accommodate the side arms so that the lenses lie at a correct angle length of the side arms. All of this additional work is costly and leads to an unacceptable aesthetic appearance of the finished spectacles.

In addition to drilling holes in lenses, it may be a requirement that the lenses undergo further cutting or edging to shape the outline of the lens. It is usual to finalise the cutting and shaping of the lenses before drilling holes in them.

Presently, CNC machines manipulate the lenses so that they may be rotated around the axis substantially normal to the convex or concave surface of the lens. See for example GB 225022A, GB 583202A and US 3417454A. If drilling and cutting operations are to be performed on the lens by the same CNC machine, a problem arises from the fact that lens slippage can occur about this axis when the cutting tool of the machine comes in contact with the lens.

An object of the present invention is to provide a CNC machine that exploits the fact that the convex surface of most lenses are of a common profile irrespective of the size, the perimeter shape, or optical specification of the lens. The invention also exploits the fact that the mounting blocks for producing the lenses are securely bonded to the convex surface of the lens and provides a table that enables the holes to be drilled from the convex surface of the lens in a direction towards the concave surface.

A further objective of the present invention is the ability to combine the two processes of shaping the edge of, and drilling into the lens.

According to the one aspect of the present invention there is provided:

A jig for mounting one or more lenses on a two axes coordinate movement bed of a CNC machine for machining the one or more lenses, said jig comprising a carriage having one or more lens holders for holding one or more lenses, each lens having a mounting block bonded to a convex surface of the lens, said carriage being rotatable about a first axis so as to be able to present one or more lenses to a tool of the machine at a position where it is desired to machine the one or more lenses said one or more lenses being constrained to restrict rotation of the one or more lenses about an axis normal to the concave and/or convex surfaces of the one or more lenses.

The CNC machine may be provided with a lens cooling means.

The carriage may be rotatable about a first axis through an angle of at least 300° or could be rotatable through an angle of 360°.

Preferably the mounting block on the, or each, lens, has a spigot, the lens holder has one or more sockets into which the or each, mounting block fits in a predetermined position, and securing means are provided for holding the spigot in the socket.

Preferably the securing means comprises a vacuum means for applying a vacuum to an underside of the or each spigot to hold the spigot in the socket but other types of securing means could be used. For example, a mechanical means, or magnetic means, or a grub screw type of fixing.

Ideally the mounting block and the lens holder include features that ensure that the spigot does not revolve in the socket.

Ideally the carriage is mounted in a carrier frame so that the carriage is rotatable about an axis that lies orthogonal to said first axis.

In one embodiment of the present invention the tool is a drill bit for drilling holes through the one or more lenses.

In another embodiment of the present invention the tool is a bit for edging, reshaping and/or cutting the outline of the one or more lenses.

The present invention will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 shows a pair of rimless spectacles;

Figure 2 shows a side view of a lens mounted on a mounting block;

Figure 3 shows a perspective view looking down on a jig constructed in accordance with the present invention showing the lenses in a first position;

Figure 4 is another view of the jig of Figure 1 showing the lenses in a first position;

Figure 5 is another view of the jig of Figures 3 and 4 showing the lenses in a second position;

Figure 6 is a further view of the jig shown in Figure 5 with the lenses in said second position, and

Figure 7 is a second embodiment of the present invention showing the jig of Figure 3 mounted in a cradle.

Referring to Figure 1 there is shown a pair of spectacles (10) comprising frames (11) and two rimless lenses (13, 14) interconnected by means of a nosepiece (15) having nose rests (16). The present invention is concerned with a jig for drilling the holes (17, 18) in each of the lenses (13, 14).

Referring to Figure 2 there is shown a lens (13) mounted on a mounting block (19). The mounting block (19) has a feature in the form of a serrated collar (20) and a spigot (21) that registers with complementary features on a lens holder (36) as will be explained later. The mounted block (19) is bonded to the concave surface of the lens (13) by means of an adhesive that permits the block to be removed from the lens when the manufacturer of the lens and drilling of the holes is complete.

Referring to Figure 3 there is shown a perspective view of the jig constructed in accordance with the present invention. The jig comprises a base plate (22) having upstanding flanges (23) and two anchor plates (24) that are screwed to the flanges (23) by studs (24(a)). The anchor plates (24) are fixed to a bed (not shown) of a

CNC drilling machine by studs (25). The bed of the CNC machine is capable of moving along two orthogonal axis (shown by the arrows x and y) in a precise manner related to a vertically mounted drill (26). The drilling head (27) also includes a touch probe (28), the function of which will be described hereinafter.

The jig has two sidewalls (31, 32) which have aligned journal bearings (33). A rotatable carriage (29), for carrying a pair of lenses (13, 14), is mounted in the journal bearings (33). The carriage (29) has a spindle (34) on which is mounted a pulley wheel (35) (see Figure 4). The carriage has two lens holders each in the form of a socket (36) (one of which is shown in Figure 2), that are mounted in slots 29(a) in the carriage (29). Each lens holder (36) has a serrated collar (37) that matches the serrated collar (20) on the mounting block (19). The mounting block (19) is inserted into the lens holder (36) and includes a feature such as a recess (38) (see Figure 2) in which a pin (not shown) on the lens holder (36) locates, so that each lens is precisely located on the carriage (29) in a position that is unique for each lens (13, 14) relative to a datum position defined when the lenses were ground to make up the optical prescription.

Each lens holder (36) has a screw threaded hole (40) into which is screwed a vacuum pipe connector and flexible pipe (41) that is connected to a source of vacuum such as a suction pump (not shown).

In Figure 3, the lenses (13, 14) are shown with the concave surface (42) of each lens (13, 14) facing upwards and this would be the position where one could drill the holes (17, 18) in a direction from the concave surface (42) towards the convex surface (43).

In accordance with the present invention, the carriage (29) is rotatable through 360°, although as will be explained later, it is only necessary to rotate the carriage through an angle of about 300° in order to drill from the convex surface towards the concave surface. In practice, the vacuum pipes (41) prevent the carriage (29) from rotating through 360° freely. In an alternative arrangement, the vacuum pipe (41) could be connected to a connector (not shown) at the end of the spindle (34) that allows rotational movement of the carriage (29) relative to a stationery part of the connector, whilst allowing a vacuum to be applied to the lens holders (36) to hold the mounting blocks (19) in place.

One of the sidewalls (31) has a stub axle (49) spaced from the axis of spindle (34), on which is mounted an idler pulley (44). The sidewall (31) also has a hole (45) through which projects a spindle (46) of a stepping motor (47). Mounted on the stepping motor spindle (46) is a driving pulley (65). An endless belt (48) shown dotted, extends around the pulleys (35, 44, 65).

The motor (47) is driven forwards or backwards precisely under the control of a software driven electronic control circuit (50) (see Figure 5). The control circuit (50) also controls the precise movement of the bed of the CNC machine in a manner well known to an expert in the field of CNC machines. In this way, the lenses (13, 14) can be precisely located at a predetermined angle relative to the drill (26) in order to drill the holes (17, 18) at exactly the correct position and angle.

The touch probe (28) on the drilling head is also used to locate a predetermined point on the lens (13, 14) such as, for example, the edge of the lens profiled in an x or y coordinate position. The touch probe (28), or indeed another probe (not shown), is used to locate a predetermined point on the concave profile of the lens (13, 14) by moving the drill (26) or the bed of the CNC machine in a z direction that is orthogonal to the x and y coordinates.

The stepper motor (47) is used to control the angle that each lens (13, 14) is tilted about the axis of the spindle (34) so that each hole (17, 18) is drilled at a desired angle normal to the tangents on the convex surface of the lens (13, 14) where the drill (26) contacts the convex surface.

In a further embodiment of the present invention shown in Figure 7, the base plate (22) of the jig is itself tiltable relative to the bed of the CNC machine about an

axis (60) that is orthogonal to the axis of the spindle (34) by providing the base plate (22) with a spindle (61) that is mounted in journal bearings (62).

In operation, in order to drill the holes (17, 18) the lens (13, 14) the lenses are mounted (with the mounting blocks (19) on the convex surfaces) in the lens holders (36) on the carriage with the concave surface (42) facing upwards as shown in Figure 3.

The carriage (29) is then rotated under the control of the stepping motor (47) to bring the concave surface (42) facing upwards as shown in Figure 4. The lens is then held stationary relative to the jig and remains stationary during drilling. This is the position where one would drill the holes (17, 18) from the concave surface (42) towards the convex surface (43). In order to drill from the convex surface (43) towards the concave surface (42) the carriage (29) is rotated through an angle of at least 180° from that shown in Figure 3 to that shown in Figure 5. The carriage is rotated to angle the lens at the appropriate angle to produce the holes (17, 18). The optical specification and shape of the lens, and the desired position of the holes (17, 18) relative to the optical prescription are entered into the software of the control means (50).

The bed of the CNC machine is moved to bring the edge of one of the lenses (13) into contact with the touch probe (28) to set a datum position in the x and y coordinate directions. The touch probe (28) is then used to locate the concave

surface (42) of the lens in the case where the lens is positioned as shown in Figure 3, or the convex surface (43) where the lenses are positioned as shown in Figure 5 and the bed of the CNC machine is moved along the x and y coordinates to position the lens (13) beneath the drill (26). The stepping motor (47) is driven to tilt the carriage (29) and thereby move the lens (13) at the correct angle relative to the axis of the drill (26), and the first hole (17) is drilled in the lens in a direction from the convex surface (43) towards the concave surface (42).

The CNC bed is then moved along the x and y coordinates, and the stepping motor (47) is driven to tilt the lens (13) to the correct angle relative to the drill (26) in order to drill the second hole (18) through the lens (13) in a direction from the convex surface (43) towards the concave surface (42).

The bed of the CNC machine is then moved again along the x and y coordinates and the procedure described above is repeated in order to drill the two holes (17, 18) in the second lens (14).

In the instance of the apparatus as shown in Figure 7, where the carriage (29) is tiltable effectively about two axes, by virtue of the fact that the jig itself is tiltable about the axis through the anchor plates (24), the control circuit (50) controls the tilt of the jig relative to the bed about the two orthogonal axis in order to drill the holes (17, 18) at the correct angle. The present invention is suitable for drilling

holes (17, 18) and for countersinking the holes to accommodate standard length studs or screws in lenses of varying thicknesses.

In a further embodiment of the present invention, the jig is provided with a cooling means (not shown) so as to cool the lens during the drilling or cutting of the lens. An example of a cooling means is a cooling fluid that can be run over the lens at the region where the machining is taking place.

The jig of the present invention as hereinbefore described may be used for machining the outline shape of lenses. In this case, the drilling tool is replaced with a cutting or an edging tool. The function of a cutting or an edging tool is to cut, edge and/or finish the outline of the lens to a desired shape. During this operation the lens remains stationary relative to the jig but relative movement between the lens and the tool effects machining of the outline shape. The advantage presented by this design feature is that both processes of cutting and drilling may be performed on the same machine with a single tool change.

A further advantage is that the space above the jig is free of structure that would otherwise collide with the cutting or edging tool.

It will be appreciated that the jig hereinbefore described is designed to fix the lens so as to constrain any rotation of the lens about an axis normal to the convex or concave surface of the lens (that is, the lens does not turn around a centre point).

The common error of previous machines of lens slippage caused by the force of the cutter against the lens can therefore be reduced or even eliminated.